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G4020 SITE LIGHTING

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RECORD OF REVISIONS

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1	11/18/02	General revision and addition of endnotes. Replaces Subsection 252.	David W. Powell, <i>FWO-SEM</i>	Kurt Beckman, <i>FWO-SEM</i>

G4020 SITE LIGHTING

1.0 CRITERIA

1.1 General

- A. Provide exterior, roadway, parking facility, and security lighting that will promote safety and security, conserve energy, and preserve the environment.
- B. Comply with the New Mexico Night Sky Protection Act.¹ *Exceptions to the New Mexico Night Sky Protection Act may be granted on a case-by-case basis for special situations such as the illumination of flags.*
- C. Select, locate, and aim luminaires to minimize the unintentional illumination of adjacent terrain² and so that glare is not directed towards any guard station.

1.2 Exterior Lighting

Design exterior lighting systems (e.g. safety and landscape lighting) according to Chapter 21 of the IESNA *Lighting Handbook*.³

1.3 Roadway Lighting

- A. Design roadway lighting systems in accordance with IESNA RP-8 (ANSI)—*Roadway Lighting* and Chapter 22 in the IESNA *Lighting Handbook*.⁴
- B. Determine the appropriate maintained luminance and illuminance for roadways using Figure 22-8 in the IESNA *Lighting Handbook*.
- C. Use the following roadway classifications as the basis for determining the appropriate maintained luminance and illuminance for roadways:⁵
 1. **Major:** The parts of the roadway system that serve as the principal network for through traffic flow. Major roadways at LANL are limited to:
 - West Jemez Road (NM501) within TA-3.
 - Diamond Drive within TA-3.
 2. **Collector:** These are roadways used mainly for the main traffic movement within developed areas. The principal roadways within highly developed parts of LANL technical areas are classified as collector roadways.
 3. **Local:** Roadways used primarily for direct access to facilities within highly developed LANL technical areas; they do not include roadways carrying through traffic.
- D. Use the following area classification (abutting land use) as the basis for determining the appropriate maintained luminance and illuminance for roadways:
 1. **Residential** (characterized by few pedestrians at night):⁵ All developed LANL Technical areas.

2. **Rural:** All undeveloped areas.
- E. Except for intersections, roadways in rural areas at LANL are generally not illuminated.
- F. Illuminate the following intersections in accordance with Chapter 22 in the IESNA Lighting Handbook; illuminance and luminance shall be not less than the sum of the recommended values associated with each roadway that forms the intersection:⁶
 1. Intersections of major, collector, and local roadways in “residential” (developed) LANL Technical Areas.
 2. Parking lot and high volume driveway connections to roadways in “residential” (developed) LANL Technical Areas.
 3. Isolated intersections ⁵ of major roadways and major roadways in rural areas.
 4. Isolated intersections of collector roadways and major roadways in rural areas.
 5. Isolated intersections of collector roadways and collector roadways in rural areas.

1.4 Pedestrian Walkway Lighting

Design pedestrian walkway lighting systems in accordance with Chapter 22 in the IESNA *Lighting Handbook*.⁷

1.5 Parking Facility Lighting

Design parking facility lighting systems in accordance with Chapter 22 in the IESNA *Lighting Handbook*.⁸

1.6 Security Lighting

- A. Provide security lighting to permit detection and assessment of adversaries and to reveal unauthorized persons.⁹
 1. Security lighting in Protected Areas, Material Access Areas, and Vital Areas shall be adequate to provide 24-hour visual assessment. ⁹
 2. Provide a minimum 2 foot-candle illumination at ground level for at least a 30-foot diameter around protective personnel posts, and 0.2 foot-candle illumination for 150 feet in all directions.⁹ Use multiple luminaires and circuits so the failure of one lamp or one circuit will not leave an area in total darkness.¹⁰
 3. Keep light glare to a minimum in situations where it would impede effective operations of protective personnel; interfere with highway traffic; or be objectionable to occupants of adjacent properties. ⁹
 4. Locate light sources on protected perimeters so that illumination is directed outward wherever possible. ⁹
- B. Design security lighting systems in accordance with Chapter 29 in the IESNA *Lighting Handbook*.¹¹

1.7 Calculations

Perform lighting calculations using procedures outlined in the IESNA Lighting Handbook. Use point-by-point methods for exterior applications.¹²

2.0 LUMINAIRES

2.1 General

- A. Use luminaires with cut-off type distribution for site lighting. Luminaires shall be constructed or shielded such that the light emitted by the luminaire is projected below a horizontal plane running through the lowest point on the luminaire where light is emitted.¹³
- B. Use high-pressure sodium (HPS) light sources for all site lighting.¹⁴
- C. On security lighting systems use "instant re-strike" lamps or "hot re-strike igniters" and standby power sources to maintain illumination in the event of power interruptions.¹⁵
- D. Minimize the number of lamp and ballast types on each project.¹⁶
- E. Provide luminaires that are NRTL listed and labeled for their indicated use and location.
- F. *To the extent practical, appearance of luminaires should be similar to existing lighting in adjacent buildings or areas.*
- G. Install luminaires in accordance with NECA/IESNA 501-2000 (ANSI), *Recommended Practice for Installing Exterior Lighting Systems*.¹⁷
- H. Refer to LANL Construction Specifications Section 16525 - *Exterior Lighting System* for luminaire materials and installation methods.

2.2 Site Luminaire Schedules

- A. Provide luminaire schedules in design packages that unambiguously describe luminaires, poles, and accessories.
- B. *Luminaire schedules should contain the following information for exterior lighting:*
 - *Fixture type designation (e.g. "R")*
 - *Quantity and Description of fixture (e.g. One 400 watt high pressure sodium floodlight with NEMA 6X5 type beam spread)*
 - *Description of materials (e.g. Cast aluminum housing and tempered glass lens)*
 - *Description of mounting (e.g. Adjustable knuckle type slipfitter)*
 - *Description of fixture finish (e.g. Gray enamel finish)*
 - *Description of ballast if applicable (e.g. 277V CWA ballast)*
 - *Description (ANSI code where applicable) and quantity of lamps (e.g. 1- S51WA-400/C lamp)*
 - *Description of accessories where applicable (e.g. Photocell in twist-lock socket)*
 - *Description of pole where applicable (e.g. 40 ft. tapered round steel pole)*
 - *Description of pole finish where applicable (e.g. Galvanized finish)*

- *Manufacturer and catalog number for fixture and pole (e.g. XYZ #ABCD- 1234 fixture on #LMN-98-76 pole)*

3.0 POLES

- Provide poles rated to carry the fixtures, supports, and appurtenances in an 80 mph wind with 1.3 gust factor.¹⁸
- Select low-maintenance pole finishes such as galvanized steel, natural aluminum, or anodized aluminum. Avoid pole finishes that will require periodic painting.¹⁹ *Wood poles treated with copper naphthenate per AWPA C4 may be used for temporary site lighting and for site lighting in rural areas.*
- Design pole bases to carry the luminaire(s) and pole at the indicated height above grade in an 80-mph wind with 1.3 gust factor.¹⁸
- Design roadway lighting poles to meet design criteria of AASHTO LTS-4, *Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. Roadway light poles shall have an impact attenuation feature (breakaway base) complying with AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals".²⁰ The device shall include protection for wiring and conduit at the base of the standard.
- To the extent practical, appearance of poles should be similar to existing poles in adjacent buildings or areas.*
- Install poles in accordance with NECA/IESNA 501 (ANSI), *Recommended Practice for Installing Exterior Lighting Systems*.¹⁷
- Refer to LANL Construction Specifications Section 16525 - *Exterior Lighting System* for materials and installation methods.

4.0 WIRING AND CONDUIT

4.1 Conduit

- Use conduit systems to contain low-voltage branch circuit wiring systems for site lighting.²¹ *In general, schedule 40 PVC conduit may be used for underground site lighting wiring systems.*
- Size conduits considering all conductor adjustment factors required by the NEC.
- Indicate sizes of branch circuit conduits on the design drawings and any changes on the record as-built drawings.²²
- Use materials and installation methods described in LANL Construction Specification 16111, *Conduit*.

4.2 Wiring

- A. Use copper conductors that have been sized with consideration to adjustment factors for voltage drop, ambient temperature, raceway fill, harmonics, and future loading.²³ Aluminum conductors are not acceptable.²⁴
- B. Indicate on the construction or record as-built drawings the number and size of conductors in site lighting conduit runs.²²
- C. Use minimum No. 12 AWG for branch circuit wiring.²⁵
- D. Design branch circuit conductors for 3 percent maximum voltage drop at full-connected load.²⁶ Use voltage drop calculation methods outlined in Chapter 3 of IEEE Std 141.
- E. To the extent possible, make wiring connections and splices in lighting pole hand holes.²⁷
- F. Provide individual fusing for each luminaire. Use “breakaway” type fused connectors located in the pole handhole.²⁸
- G. Identify all branch circuit conductors at each accessible location using color-coding that is consistent with that on the site.²⁹ *For minor work³⁰ at existing facilities use wiring color codes that match existing color codes so long as National Electrical Code requirements for identifying grounded and grounding conductors are satisfied³¹.*
- H. Use materials and installation methods described in LANL Construction Specifications Section 16120, *Building Wire and Cable*.

4.3 Grounding

- A. Install a 600 volt insulated (green) equipment-grounding conductor in each site lighting branch circuit raceway.³²
 - 1. Size equipment-grounding conductor per NEC section 250.122.
 - 2. Connect equipment-grounding conductor to the grounding stud in the metal pole and the grounding terminal in each luminaire.
- B. Bond the grounding stud in each metal lighting pole to a local 10-ft. driven ground rod or other available ground such as a building lightning protection counterpoise.³³ Use minimum 1/0 AWG copper cable connected with IEEE 837 approved compression fittings.

5.0 SITE LIGHTING CONTROLS

- A. Control site lighting so it is automatically turned on when ambient natural lighting becomes less than 1.6 times the illuminance design value or 1.5 footcandles, whichever is higher³⁴, and is automatically turned off when sufficient daylighting is available or the lighting is no longer needed.³⁵
- B. Control exterior lighting by means of photocell(s) and/or astronomical time switch(es) through HAND-OFF-AUTO selector switch(es) and lighting contactor(s) as follows:³⁶

1. Safety, security, pedestrian walkway, and roadway: on at dusk and off at dawn – photocell controlled.
2. Parking facility and landscape lighting: on at dusk and off at preset time – photocell on, time clock off. A small percentage of parking lot lighting shall remain on until dawn for personnel security.

ENDNOTES:

¹ The New Mexico Night Sky Protection Act which regulates outdoor night lighting fixtures to preserve and enhance the state's dark sky while promoting safety, conserving energy and preserving the environment for astronomy. Highlights of the act are available at http://www.rld.state.nm.us/cid/news/highlights_of_night_sky_protection_act.pdf. The official text of the Night Sky Act is available at www.michie.com/newmexico/lpext.dll?f=templates&fn=fs-main.htm&2.0 by following the links to New Mexico Statutes, Statutory Chapters in New Mexico Statutes Annotated 1978, Chapter 74, Article 12.

² Refer to “Light Trespass” in Chapter 21 of the *IESNA Lighting Handbook*, ninth edition.

³ Refer to Chapter 21 in the *IESNA Lighting Handbook*, ninth edition.

⁴ Refer to Chapter 22 in the *IESNA Lighting Handbook*, ninth edition.

⁵ Refer to “Classification Definitions” in Chapter 22 of the *IESNA Lighting Handbook*, ninth edition.

⁶ Refer to “Situations Requiring Special Consideration” in Chapter 22 of the *IESNA Lighting Handbook*, ninth edition.

⁷ Refer to “Pedestrian Walkways and Bikeways” in Chapter 22 of the *IESNA Lighting Handbook*, ninth edition.

⁸ Refer to “Parking Facility Lighting” in Chapter 22 of the *IESNA Lighting Handbook*, ninth edition.

⁹ Refer to Chapter 7 in DOE M 5632.1C-1, *Manual for Protection and Control of Safeguards and Security Interests*.

¹⁰ Refer to the Lighting Equipment heading Chapter 29 in the *IESNA Lighting Handbook*, ninth edition

¹¹ Refer to Chapter 29 in the *IESNA Lighting Handbook*, ninth edition.

¹² Refer to Chapter 9 in the *IESNA Lighting Handbook*, ninth edition.

¹³ Refer to the New Mexico Night Sky Protection Act.

¹⁴ High-pressure sodium lighting provides good energy efficiency, long lamp life, acceptable color rendering, and short warm-up and re-strike time. Mercury vapor lighting is prohibited by the New Mexico Night Sky Protection Act. DOE M 5632.1C-1 requires full-spectrum lighting, eliminating monochromatic low-pressure sodium. Metal-halide lamps have unacceptably short life.

¹⁵ Conventional high-intensity discharge lamps require several minutes for the arc to re-strike and for light output to regain full output after a momentary power interruption. High-pressure sodium lamps are available with double arc tubes that provide nearly instantaneous re-start in case of a power interruption.

¹⁶ Minimizing the number of lamp and ballast types reduces the costs and inventory required to maintain a site lighting system.

¹⁷ NECA/IESNA 501 is one of the *National Electrical Installation Standards*; it defines a minimum baseline of quality and workmanship for installing exterior lighting systems.

¹⁸ The highest recorded wind gust at LANL is 77 mph; refer to “Brief Climatology for Los Alamos, NM” at <http://weather.lanl.gov/html/climatology.html>. 80 mph is a standard lighting pole design.

¹⁹ Higher initial cost of pole is recovered due to much lower maintenance costs.

²⁰ Refer to AASHTO *Standard Specifications for Highway Bridges*, Division I 11.4.

²¹ LANL institutional policy developed through observation and experience. Installation of wiring systems in raceway systems protects conductors and facilitates future wiring modifications.

²² Accurate design and as-built documentation facilitates maintenance and future system modifications.

²³ Adjustments for raceway fill, ambient temperature, and harmonics are required in 2002 NEC Article 310.15.

²⁴ The 2002 New Mexico Electrical Code prohibits the use of aluminum conductors smaller than No. 2; this prohibition is extended to all conductor sizes at LANL.

²⁵ The use of minimum 12 AWG on branch circuits limits voltage drop.

²⁶ AHSRAE/IESNA Standard 90.1-2001 requires the stated voltage drop design criteria in paragraph 8.2.1.

²⁷ Objective is to reduce or eliminate site lighting junction boxes.

²⁸ Fusing of individual luminaires will prevent the failure of a ballast from disabling an entire circuit. Breakaway fused connectors ensure that exposed conductors will not endanger people should a pole fall.

²⁹ Color coding of phase conductors facilitates wiring system voltage identification and the correct installation of equipment requiring a specific phase sequence or phase rotation.

³⁰ Refer to LEM Chapter 7, D5000, “Application of this Chapter” heading.

³¹ Refer to 2002 NEC Sections 200.6 and 250.119.

³² Installation of an insulated equipment-grounding conductor is recommended practice in clauses 8.4.5.3 and 8.5.3 of IEEE Std 1100-1999. Clause 2.2.3 of IEEE Std 142-1991 indicates that the use of a metal raceway as a grounding conductor supplemented by an equipment grounding conductor achieves both minimum ground fault impedance and minimum shock hazard voltage.

³³ Purpose is lightning protection.

³⁴ Refer to the Lighting Equipment heading Chapter 29 in the *IESNA Lighting Handbook*, ninth edition. HID systems must be energized a sufficient time before darkness so full lamp output will be available at darkness.

³⁵ Refer to 9.2.1.3 in ASHRAE/IESNA Standard 90.1-2001.

³⁶ Refer to the Lighting Equipment heading Chapter 29 in the *IESNA Lighting Handbook*, ninth edition.